RESEARCH HIGHLIGHTS

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QUALIFICATION OF THE DEGREE OF ACOUSTIC COMFORT PROVIDED BY MULTI-FAMILY BUILDINGS - PHASE II

Introduction

In the report entitled *Qualification Of The Degree Of Acoustic Comfort Provided By Multi-Family Buildings - Phase I* submitted to CMHC on July 10, 1996, MJM Acoustical Consultants Inc. proposes a method of monitoring and evaluating the insulation of noise produced by human activity, plumbing and mechanical equipment in multi-family buildings to be sold as condominiums. The overall objective of this study is to provide the construction industry with a reliable tool to evaluate the level of acoustic comfort in a housing complex. The Phase II report of the study submitted on December 17, 2002 describes the process of validating on site the criteria that had been proposed during Phase I, based on theoretical studies subsidized by CMHC between 1980 and 1996. It also suggests a protocol for assessing the degree of acoustic comfort provided by a unit located in a multi-family residential building.

Validation of Selected Noise Level Criteria

Ambient noise

Based on the ambient noise data that MJM has collected since its creation in 1984, we believe that it is appropriate to use the Noise Criteria (NC) 20 as the isolation objective for noise produced by the operation of the shared mechanical and electrical equipment in the building which is transmitted into the main rooms (bedroom, living room, etc.) of a unit. This is also the case for the noise produced by the plumbing.

It is preferable to use the NC criteria rather than overall dBA levels since these criteria take into the account the frequency of intrusive noise. As we have illustrated in the case of elevators, a slight and barely noticeable increase in the overall level (dBA) as a result of elevator operation can be translated into a strong increase in sound levels at a specific frequency, which makes this noise clearly audible. Mechanical equipment, such as air conditioning and heating systems located inside units, has a neutral frequency spectrum (no pure tones): the acoustic design criteria of such systems that we have selected is NC 25 (in bedrooms, living and dining rooms).

The criteria selected for characterization of the site or building sound climate is based on urban residual noise L95 (a level exceeded 95% of the time) obtained from a five-minute sound sample taken during the day in front of the building under study. The L95 level measured in this way should preferably be equal to or lesser than 55 dBA.

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The only purpose of this criteria is to give an idea of the background or residual urban noise in the area in which the building is located. It is not intended to characterize the various sources of occasional noise in the area surrounding the building, unless the noise from these sources is continuous.

Noise produced by human activity
Laboratory and "in situ" analyses of the performance of soundproofing provided by walls (double drywall and double rows of stud walls) and the inter-unit floor/ceiling assemblies (8 - 10 in. thick concrete slab or woodframe floor/ceiling assemblies with 150 mm fibreglass between the joists, 38 mm concrete topping on resilient furring made of two 13 mm thick flame-retardant gypsum board sheets) most commonly used in the construction industry lead us to conclude that indirect sound transmission from one unit to another limits the acoustic performance of walls and FSTC 58 floor/ceiling assemblies in wood frame constructions and FSTC 60 floor/ceiling assemblies in concrete constructions. We demonstrated that the sound isolation objective of an FSTC 55 sound transmission score and acoustic separation at low frequencies of at least 38 dB for ranges in the third octave (the main frequencies of which are 125 Hz and 160 Hz) is both realistic and attainable.

With respect to isolation of impact noise, we have noted that the FIIC 65 criteria for carpeted floor/ceiling assemblies which is the current standard in the construction industry is easily attainable with both wood and concrete structures. The FIIC 55 criteria selected for wood floors is also relatively easy to achieve through the use of an appropriate membrane under an engineered floor. With respect to ceramic floors, because of the rigid support required by this type of covering (in order to avoid cracking), a less flexible membrane is required and the impact noise insulation criteria is set at FIIC 50, which remains difficult to achieve. Because of the lower isolation from impact noise provided by this type of covering, the use of ceramic, marble or granite is not recommended in rooms other than foyers, kitchens and bathrooms, where floor surface maintenance is a priority.

Suggested procedures for conducting acoustical measurements
Various suggested procedures can be found in the body of the report for conducting measurements of ambient, transient or fluctuating noise within units, and measurements of urban noise outside the building. A rapid method is also described for the measurement of FSTC and FIIC scores provided by block partitions and inter-unit floor/ceiling assemblies.

Building acoustic comfort assessment grids
Table 1 summarizes the measures to be used and the criteria to which the results of these measurements must be compared in order to assess the degree of acoustical comfort provided by a unit.

The comfort provided by a unit is described under three categories, using a scoring system that is explained in the report itself:

- isolation from exterior noise;
- isolation from noise produced by human activity inside neighbouring units;
- isolation from mechanical noise.

Study Findings

The quick method of measuring FSTC and FIIC scores is effective to the extent that the vast majority of the objectives had already been achieved when the acoustical measurements were taken. We can then conclude that the objectives set during Phase I of this research project are quite realistic and readily attainable with respect to the insulation of units in a housing complex. **Table 1** describes these soundproofing objectives and the findings when the various assemblies were tested.

Table I

DATA MEASURED	DESIRED OBJECTIVE
Outdoor residual noise	L95≤55 dBA
Outdoor noise, Leq(A) (5 min.)	Leq(ext)-Leq(int)> 25 dBA
Indoor ambient noise, Leq (A) (5 min.)	Leq(ext)-Leq(int)> 25 dBA
Indoor ambient noise L95 (5 min.)	NC20≤L95≤NC25
FSTC, inter-unit wall/floor	≥ 55 (with NR at 125 and 160 Hz ≥ 38)
FSTC corridor wall, exit stairwell	≥ 55
FIIC (hard floor) inter-unit	≥ 55 (FIIC)
FIIC (carpet) inter-unit	≥ 65 (FIIC)
FIIC (lateral transmission, exit stairwell)	≥ 55 (FIIC)
FSTC access door (1)	≥ 25 or ≥35 if the door opens onto the entrance hall or an elevator hall
L plumbing main rooms:	≤ NC 20
L (5 cycles) garage door	≤ NC 20
L condenser or water tower	≤ NC 20
L transformer	≤ NC 20
L (Max) 35ms elevator	≤ NC 20
L (Max) 35ms garbage chute	≤ NC 20

Contribution to the Construction Sector

The first phase of this research project was an attempt to develop a method of evaluating the degree of acoustic comfort afforded by multi-family residential buildings. We assembled the knowledge available on the subject, which was translated into sound insulation objectives to be achieved in multi-family structures. An evaluation protocol to economically classify each housing unit that is part of a multi-family complex was also developed. Phase II of this project made it possible to validate/amend the proposed evaluation protocol performed in buildings with wood and concrete structures. In the opinion of the authors, the Research Study on the *Qualification of the Degree of Acoustic Comfort Provided by Multi-Family Buildings* is a reliable way of measuring the degree of acoustic comfort afforded by housing complexes.

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Housing Research at CMHC

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